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"Thank you, next": A Call for Intentional Design

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Abstract

As a social network science axiom, homophily informs the current design of Web 2.0 platforms, like Spotify. As a result, sociotechnical systems propagate current hegemonic structures such as historically male dominated markets like the music industry. To understand how the current design of sociotechnical systems promote existing power structures this investigation performed an empirical social network comparison between the organic 2018 Hip-Hop collaboration network and Spotify's automated related Hip-Hop artist network. This study produced several interesting findings including, (1) organic network tie formation differs from automated networks, (2) homophilous and heterophilous connections were positively correlated with artists' gender, and (3) statistically significant homophilous male connection were observed in Spotify's related Hip Hop artist network but not in the organic network. By and large, these findings suggest that Spotify's sociotechnical architecture and affordances promote the existing patriarchal structure.

1. Introduction

For three of the past four years, Spotify's most streamed music artists of the year were all men. As *Vox* journalist, Kaitlyn Tiffany, notes this is peculiar given the current popularity and success of female music artists. For example, pop sensation Ariana Grande simultaneously held Billboard's top three top 40 hits -- a feat not achieved since the Beatles in 1964. In 2018 country singer, Kasey Musgraves won the Grammy for album of the year. On top of that, Hip-hop mogul Cardi B in 2017 released the first female rap single to reach number one since 1998. *So why are Spotify's most streamed music and content predominantly produced by male artists?* Spotify claims this is "how 191 million people around the world stream music and content". However, recent algorithm bias studies suggest otherwise. The following paper presents a social network analysis investigation to understand the role a platform plays in magnifying existing hierarchal structures.

Spotify is a Swedish audio streaming platform that services 207 million users in 19 countries [20]. As of 2017, is supports over two million artists, which suggest that the application offers a longtail range of options [3]. Recent findings, however, reveal a steep power law in which most artists report low popularity scores. Artist popularity scores are algorithmic measurements that compare artists by dividing their total number of streams by the number of streams of the most listened to artist [41]. Observing power laws is not a new phenomenon in network science. Most studies report that the top 10 to 20 percent of actors command the network's attention and visibility[16, 36, 33, 5, 6]. On Spotify, 94.47% of the platform's content comes from artists with a popularity score above 5 [51]. The presence of these power laws and Spotify's reputation for producing male-dominated charts indicate that more is at play than just the way users interact with the platform. Ultimately it begs the question: *to what extent does the platform's structure contribute to producing male-dominated chart?*

2. Literature Review

Spotify's popularity and public Application Programming Interface (API) offers a unique opportunity to examine how automated networks differ from those that occur organically like collaborations amongst music artists. Like organic networks, Spotify's sociotechnical architecture and affordances create multi-dimensional networks [13]. One dimension of these networks is produced by the platforms algorithmically derived playlists, which users utilize to curate personal playlists [42]. A recent micro-study suggests that Spotify's automated playlists promote male artists over female, non-binary, or artists that identify as other.

In her month-long observation, Pelly [35] found that 85.5% of the tracks on Spotify's most followed playlist included male artists, whereas 45.5% included female artists [35]. Unfortunately,

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algorithmically promoted gender bias is not news to Spotify. On March 2, 2017, the platform partnered with Smirnoff to produce Smirnoff Equalizer--a website designed to let users know what percentage of their streams featured women artists. Disguised as an effort to offset gender bias this marketing strategy proved to be nothing but a glitchy website that promoted already well-known female artists such as Aretha Franklin and Joni Mitchell. To Spotify's credit, however, the company continues to seek out different approaches to tackle this issue. The following year, it launched a new hub of playlists called "Amplify," which is designed to promote music related to social issues. Its first playlist, "women of the world," celebrated Women's History Month [35].

From a network science perspective, it is not surprising that Spotify magnifies the same bias etched in the industry's history. Like other Web 2.0 systems, Spotify translates "old forms of social segregation" by programming algorithms to produce playlists by "recognizing patterns in input data" [4]. If algorithms are fed data oversaturated with content produced by male artists, then the playlists they create will overly represent male artists. Given the industry's male-dominated history, simply creating playlists that promote women or marginalized voices will not offset network effects. To begin to understand how to offset gender bias necessitates a network science approach that examines the relations among the patterns of the data the platform processes, produces, and promotes.

This project presents a comparative social network analysis between an organic network and an automated network to understand the extent to which Spotify's architecture and affordances are responsible for producing gender bias. Whereas the actors themselves forge connections in organic networks, algorithms forge ties in automated networks. For example, on each artist profile, Spotify provides an algorithmically derived list of related artists. The list of related artists is a sociotechnical feature designed to expose users to similar artists. In providing this list, Spotify forges ties among different artists, thus producing an automated network of related artists. Music artist collaboration networks, on the other hand, are established from ties that the actors themselves form by collaborating with other artists. Currently, both organic and automated networks promote homophilous male connections. In attempting to understand how to offset this bias, this project employs a sociotechnical approach, which argues that technology and its effects are shaped by not only how users interact with an application, but also by how the platform's architecture and affordances are designed to guide user interaction. By comparing an organic network to an automated network, this paper attempts to understand the role Spotify's architecture and affordance play in promoting current hegemonic structures.

2.1. Theoretical background

Whereas network theory is central to understanding organizational processes, social network theory, examines the relationships among the actors of a network. Ultimately, social network analysis is a social science approach that examines the relations among actors in a given network and understanding the nature of these relationships reveals the possibilities of said network [21, 12, 17, 30, 44]. Central to this framework is a particular type of tie, weak ties-- superficial connections capable of strengthening a network characterized by small worlds [18] They are "weak" in the sense that they are acquaintances or friends of friends that bridge clusters of niche groups, thus strengthening a system's structure as they diversify and expand a given network's reach [5, 18, 38]. Without them, internally homogeneous collectives run the risk of becoming echo chambers-- isolated clusters disconnected from other strongly bonded groups [38]. Barabasi's [5] work on the World Wide Web revealed hubs or highly connected nodes, which suggested the presence of a web hierarchy. Today, Barabasi's study stands as "the strongest argument against the utopian vision of an egalitarian cyberspace" and paved the direction of social network analysis that followed the turn of the century.

In recognizing the ability for certain actors to have more connections than others, understanding power dynamics in networks became central to understanding how networks function [12]. Following the new millennium was the Web 2.0 revolution, which catalyzed an era of sociotechnical processes and architecture that materialized the flow of information, thus providing a means to empirically track a single individual's influence [43, 28, 40]. Studies on influence dates back to Katz and Lazarsfeld's [19] two-step model. Since then, scholars realized that opinion leaders are not always the most connected nodes in a network [30]. Thus, illustrating how one's position in a network is a better predictor of influence. Among the many different positions in a network is the gatekeeper, which provides the shortest path between clusters of nodes. Removing these agents would collapse the structure of the network into several small disconnected, isolated collectives. Gatekeepers are thus the actors who affect the nature of a network's ties the most. Following previous gatekeeping social network science studies, this project employs betweenness centrality, or the measure of one's ability to bridge connections, as its

metric of prominence [8]. Therefore, to examine how automated networks differ from organic social systems, this investigation proposed the following research question:

RQ1: Which actors bridge the most connections in each network?

2.2. Homophily vs heterophily: why not both?

Identifying the prominent actors of each network provides a means to assess the underlying social network principle, homophily. Perceived as an axiom by most network scientist, this concept describes the tendency for individuals to form groups with like-minded individuals [27]. Homophily suggests that segregating into groups in which our neighbors look and think like us is natural. Lazarsfeld and Merton [23] first coined the term, which has since been understood not just as a representation but a model of collective organization [4]. The earliest cited evidence of homophily originates from ethnographic studies centered on small groups. Without controlling for the effects of slavery, segregation, and economic inequality, these small urban neighborhoods presented "substantial homophily" demographic and psychographic characteristics [27, 9, 24, 39]. In the 1970s and 1980s, network scientist expanded their mythological approach to included new sample surveys. The ability to access networks in large systems prompted large-scale homophily studies capable of generalizing the results to a known population. As the focus shifted from informal social networks to those that arise in an organizational context, evidence of homophily was found in every type of social tie, including marriage, friendship, advice, work etc. [27] -- inciting an era of research that assumes homophily along the dimensions of race, ethnicity, sex, and status as a grounding organizing principle.

Despite deriving from structural analysis research, the studies cited above omit critical social structural effects that mold collective organization. As Chun [4] acknowledges, they ignore the historical effects of hegemony—social hierarchies instituted by systematic slavery, segregation, and discrimination. Although claiming to map inequality [11], network science obviates politics, sexism, and racism. Instead of criticizing, it validates current systems of segregation as it poses our gravitating toward like-minded individuals as a natural organizing principle. Instead of diversity, it assumes the foundation of collectives, communities, and neighborhoods rests on commonality defined by physical, psychological, and socioeconomic traits. Instead of being a "starting point for deeper questions," homophily "cooks the endpoint it discovers" [17, 4]. In aligning itself with scholars like Wendy Chun, Safiya Noble, Kate Crawford, Joanne Sidon, and Warren Sack, this project does not assume homophily as an organizing principle. Instead, it aims to detach network science from this assumption as its main objective is designed to understand the extent to which homophily informs the current state of sociotechnical architecture and affordances and therefore proposed the following inquiry:

RQ2: To what extent are the ties forged by prominent actors driven by homophily?

2.3. Architecture and affordances

By now, the effects engendered by the internet's inception and adoption of Web 2.0 applications is more redundant than novel. Although the utopian promise of a virtual democracy was deemed empty, these systems fundamentally altered the structure of connection, dissemination, and markets [22, 10, 28, 2, 3]. Specifically, for the music industry, the digital revolution allowed users to not only listen to music on the go but to be selective in their consumption. Whereas the physical format of CDs and records force people to buy unwanted content, digital streams provide customers with the liberty to custom build music libraries [3]. Streaming services took this one step further, creating a market in which users do not own music but instead rent it. The rapid proliferation of these systems profoundly impacted the relationship between consumer and music. While very few studies have explored the impacts of this changing market, less have considered how consumers' evolving relationship with music affects music artists and the connection they form with one another.

Rather than measuring an artist's success via awards, albums, and ticket sales, these systems quantify their popularity by the measure of generated streams. Concerts, festivals, and collaborations are at risk of becoming outdated modes of networking as they are increasingly replaced by automated features such as track and artist radios, playlists, and related artist recommendations. In response to Spotify's success, a form of competition driven by fostering consumer retention materialized as other platforms attempted to enter the market [26], thus prompting a state of sociotechnical architecture and affordances designed to retain consumers by capturing usage data that informs their future decisions. Spotify, hence, is a conglomerate of algorithms programmed to function as conduits of aggregated human behavior developed to inform user retention [37, 28, 26]. As a result, recommendation systems construct artist networks not established by music artists but by automated

recommendations whose fabric of design is riddled with human bias [4, 32 , 34].

Overall, Spotify's male-dominated charts mirror current hegemonic structures. These charts symbolize the consequences of a sociotechnical architecture that promotes homophily versus diversity. As a result, Web 2.0 applications have become the culprits of magnifying existing social ills [10, 4]. To further understand the role Spotify's sociotechnical architecture and affordances plays in the current divide between male and female music artists, this investigation proposed the following research question:

> *RQ3: To what extent do Spotify's sociotechnical architecture and affordances drive homophilous connections?*

3. Methods

The main objective of this study is to understand what role Spotify's sociotechnical architecture and affordances play in driving homophilous ties forged by actors of a given network. In its aim to do so, this investigation examined the differences between an organic network—a network in which the connections are forged by the actors themselves—and an automated network—a network in which ties are manufactured by algorithmic calculations. The following presents the blueprints of a comparative social network analysis between the 2018 music artist collaboration network and Spotify's related artist network.

3.1. Capturing the networks

To capture the music collaboration network necessitates a complete list of 2018 songs This project first created a JavaScript to scrape Wikipedia's 2018 albums page to compile a list of albums released in 2018. This list was then used to query Spotify's API to collect a list of tracks released in 2018. Since this process did not capture singles and EPs, a more comprehensive list of music artist collaborations was obtained by processing random queries. The following parameters were established to perform an in-depth social network analysis. Songs that reported a zero popularity score, had more than twenty artists, and whose principal artist genre returned null were removed. Tracks whose principal artist reported popularity score less than five were also removed since 94.47% of Spotify's artists' popularity score is above five. Lastly, only collaborations involving artist identified as actors of Spotify's hip-hop network were collected.

According to South (2018), Hip Hop artists are the most central actors that forge the most connections on the platform. Additionally, focusing on a single genre permits a more in-depth analysis. To identify the 2018 hip-hop collaboration network, a complete list of Spotify's genres sorted by most to least related to hip-hop from an open-source website to identify Spotify's hip-hop artist. The included songs were those in which the principal artist reported a genre that was among the top twenty percent most related to hip-hop. From these parameters, a list of 2018 hip-hop collaboration tracks was obtained to create the 2018 hip-hop collaboration network. Using the subset of qualified hip-hop artists that released collaborations 2018, Spotify's API was queried to collect the list of related artists presented in each artist's profile. These procedures supplied a subset of 26,554 songs and 58,282 unique actors.

Given Hip-hop's history with Black and Latinx communities, race and ethnicity are an expected factor of homophilous effects. However, the data that is readily available to researchers limits this project. To date, there is no database or open-source software that provides the racial and ethnic profile of each music artist. While future research must take a critical race and technocultural approach to holistically understand the processes involved in forming connections among music artist, this project remains concerned with the effects of gender since this information is attainable for all artists observed in this study.

3.2. Locating the prominent actors

Research question one asks to identify each network's gatekeepers. Although many different centrality measures have been used to pinpoint these agents, past studies indicate that betweenness centrality best serves the purposes of this study. Betweenness centrality measures an individual's ability to bridge connections in a network [31]. As the gatekeepers of the network [28], the members with the highest betweenness centrality provide the shortest path between clusters of nodes [8]. If these actors are removed, the network collapses into smaller disconnected, isolated collectives. Individuals with the highest betweenness centrality are, thus, in the most significant position to influence the nature of forged connections. Therefore, to locate each networks prominent actors this projects employed betweenness centrality as its prominence metric. Following previous social network studies, this investigation defined prominent actors as the top twenty percent of actors with the highest betweenness centrality [33, 6, 7].

3.3. Challenging homophily

As previously mentioned, homophily is an underlying network principle that describes the tendency for individuals to form connections with like-mind individuals. This tendency has been since framed as an axiom organizing principle, thus informing the way sociotechnical systems automate connections among the actors of their network. Scholars such as Boyd [10], Nobel [32], and Chun [4] have supplied findings that suggest that the way we interact with the current state of sociotechnical architecture and affordances magnifies existing social ills. In aligning with these scholars, this paper argues that the architecture and affordances of these systems promote homophilous connections, causing those already disenfranchised to be further marginalization. This project recorded each actor's gender, genre count, popularity score, and follower count to understand the extent to which a platform's design and features drive connections. The ego networks of the top twenty percent with the highest betweenness centrality were extracted using R, a software environment for statistical computing. Descriptive statistics were calculated to gain a general sense of the type of connections the prominent actors formed. Then, dyad-level exponential random graphic models (ERGM) were conducted to assess how homophilous or heterophilous each prominent actor's ego networks were based on gender, genre count, popularity score, and follower count.

3.4. Comparative network analysis

The last research question was developed to understand the extent to which Spotify's sociotechnical architecture and affordances affects the nature of ties forged between actors. Comparative network analysis is required to answer this question; unfortunately, social networking statistical analysis software does not provide a means to conduct comparative analyses between networks of different sizes. So, to answer this question, a two-step exploratory statistical analysis was performed. Whereas research question two evaluated and tested the significance of gender as a dependent variable in tie formation, the following methods assess the degree to which tie formation is dependent on an actor's genre count, popularity score, and follower count. To assess the extent to which these factors drive homophilous connections necessitates a comparison of the range of difference between two actors genre count, the popularity score, and follower count. Therefore, this study documented edge attributes (genre count difference, popularity difference, and follower difference) for each edge observed in this study. Quartile distributions were then conducted to measure how homophilous/ heterophilous each networks' ties were. This investigation performs relational level ERGMs to test the statistical significance of these results. Lastly, a comparative analysis was performed to evaluate the differences between an organic network and an automated one using this data.

4. Results

4.1. Identifying prominent actors

This investigation defined prominent actors as the top twenty percent with the highest betweenness centrality. Since gatekeepers bridge connections they have the most potential to affect the network's structure. 4,019 gatekeepers were found in the organic network, and 8,880 gatekeepers were identified in the automated system (see **Figure 1** and **Figure 2**). As illustrated in Table 1, each network was dominated by male actors, while female music artists remained significantly underrepresented (organic network: 7.02%; automated network: 8.02%). While their distribution of gender was similar, differences in popularity scores between each network's top twenty-five actors were observed (see **Table 2** and **Table 3**). Ty Dolla $ign, Future, Gucci Mane, and 2 Chains are currently some of the most popular rappers in the hip-hop industry and reported popularity scores that ranged from 90 to 86 (100 is the highest). It is not surprising that these artists were among the top twenty-five prominent actors of the 2018 Hip-Hop artist collaboration network. Jesse Baez, Kali Uchis, Choclock, and Normani were among the top twenty-five prominent actors of Spotify's related Hip-Hop artist collaboration network. However, these artists are fairly unknown or are currently on the rise as is seen in the range of their popularity (scores 85 to 48). Whereas the average popularity score for the 2018 Hip Hop artist collaboration network's top twenty-five actors is 84, Spotify's related hip-hop artist network's top twenty-five artist reported a medium average (55). These differences indicate that an artist's popularity is a predictor in organic collectives, but not for automated ones. These results, however, reflect each network at a specific place and time. Future in-depth qualitative social network analysis studies should be conducted to provide a general understanding of the compositional and structural differences between organic and automated network.

4.2. Homophilous nature of ties

Seeking to understand the extent to which homophily drove prominent actors' ties, this project extracted the ego networks of all the prominent actors of each system and performed dyad-level ERGMs (see **Table 4** and **Table 5**). The 2018 hip-hop collaboration ego network displayed statistically significant homophilous for nodes characterized as group or other. Additionally, this study observed significant heterophilous ties between female artists and artists that identified as other. These results hint at the presence of stronger ties between underrepresented groups. Contrastingly, Spotify's automated network reported statistically significant homophilous connections among male artists and artists who identify as other and statistically significant heterophilous connections between music groups and non-gender conforming actors and non-gender conforming artist and actors who reported a null gender. These results align with previous homophily assumptions and effects. In both networks, non-gender conforming music artists tended to establish connections with one another, which is a known effect among minorities. This investigation observed homophilous connection between the observed actors who made up each network's minority. These results, however, do not suggest that homophily is an organizing principle in both networks; it indicates the platform's like Spotify are designed to be conduits that mirror existing social processes. Additionally, the empirical findings presented in this study indicate that Spotify's architecture and affordances promote homophilous connections between male artists. The implications of these findings are discussed in the following section. Lastly, both systems displayed significant heterophilous connections. Therefore, these results illustrate the value of future research examining heterophilous ties and their effects on an individual's position in the network.

4.3. Impact of sociotechnical design

Using the 2018 Hip Hop artist collaboration network as the basis of comparison, research question three's underlying objective was to assess the extent to which homophilous/heterophilous connections drove the relations established in each network based on gender, genre count, popularity score, and follower count. The distribution of edge attributes for each network was calculated to assess the similarities and differences the connections forged by each system's prominent actors (see **Table 6**). Relational level ERGMs were conducted to test the dependency of genre count difference, popularity score difference, and follower count difference in tie formation for both networks of prominent actor ego networks. The results from research question two were used to assess the role gender played in establishing ties. Neither genre count difference, popularity difference, nor follower count difference was statistically significant variables in either network (see **Table 7**). These findings do not suggest that these characteristics do not influence tie formation in these networks; it does, however, indicate that they were not statistically significant variables in the connections captured during this study. Each network displayed gender as a statistically significant variable in the formation of homophilous and heterophilous ties. As expected, homophilous male ties were found among the ego networks of the prominent actors of Spotify's related Hip-Hop artist network. The following section discusses the implications of these results.

5. Discussion

Overall, this study's central purpose was to evaluate how Spotify's design and features affect the nature of the ties in a network in which aggregated user data informs connection. Research question one located the gatekeepers, or prominent actors, of each system. Since gatekeepers bridge connections, betweenness centrality defined each actor's level of prominence. In the 2018 hip-hop artist collaboration network, 4,019 prominent members were identified, and 8,880 actors were located in the related hip-hop artist system. While gender distribution was the same across both networks, the top twenty-five actors of each network differed significantly in popularity score. Whereas the prominent members of the organic network were some of the most streamed artists on Spotify, the individuals who bridged the most connection in the automated network reported mid-range popularity scores. These popularity score differences suggest that the process of forming connections between actors in an organic network differ from those in an automated one. Future research should examine the logic of connection in automated systems.

Research question two evaluated the extent to which the gatekeepers forged homophilous ties. In both networks, homophilous and heterophilous connections positively correlated with gender. Genre count, popularity, and follower count did not produce statistically significant correlations. The last research question guided this study's central purpose as it sought out to examine the extent to which Spotify's sociotechnical architecture and affordances affected the nature of automated network ties. Although genre count difference, popularity difference, and follower difference did not produce statistically significant results, this does not suggest that researchers should not consider them as dependent variables in future

studies. These results do, however, indicate that for the networks captured during this study, the difference between each node's genre count, popularity score, and follower count did not play a significant role in establishing connections. Moreover, this was true across both networks, which is noteworthy given that past studies suggest the design of sociotechnical systems function as conduits rather than active agents. Hence, more research should be conducted to assess the validity of these results.

Perhaps the most exciting finding was that statistically significant homophilous male connections were observed in Spotify's related hip-hop artist network but not in the 2018 hip-hop artist collaboration network. These empirical results suggest that Spotify's platform promotes male homophilous connections. These findings are concerning given that three out of the four past years, Spotify's most streamed artist were mainly men. Boyd [10], Nobel [32], and Chun [4] are among some of the scholars who have brought attention to the fact that these systems do not transcend social ills but instead magnify them. As a result, Web 2.0 platforms do not function as positive, negative, or neutral actors, but instead, are in service to their usage. Algorithm bias research and the results of this study suggest that we need to reevaluate the passive nature of these sociotechnical systems.

These applications magnify existing hegemonic structures and need to be treated as such. Ultimately, this paper calls for an era of intentional design in which sociotechnical systems are intentionally designed to promote diversity instead of homophily and treated as active participants in the digital ecology.

6. Limitations

Three imperative limitations should be considered when gauging the significance of these results. First, only one sociotechnical feature was examined during this study. Future research should investigate the platforms other affordances to provide a better picture of how the platform affects the nature of the ties formed in automated networks. Secondly, a large percentage of the actors reported a null gender. This suggests that the results provided in this studied might be skewed. A qualitative approach should be employed to produce more comprehensive results. Lastly, valid statically methods to conduct a comparative analysis between two networks of different sizes do not exist. Therefore, the exploratory methodological process employed in this study needs to be validated.

7. References

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